WIRELESS POSSIBILITIES

By
A. M. LOW

From the collection of the

San Francisco, California
2006

WIRELESS POSSIBILITIES

TO-DAY AND TO-MORROW SERIES

DAEDALUS, or Science and the Future
By J. B. S. Haldane

ICARUS, or The Future of Science
By Bertrand Russell, F.R.S.

THE MONGOL IN OUR MIDST, or Man and His Three Faces
By F. G. Crookshank, M.C.F.R.C.P.

WIRELESS POSSIBILITIES
By Prof. A. M. Low

In Preparation

TANTALUS, or The Future of Man
By F. C. S. Schiller

E. P. DUTTON & COMPANY

WIRELESS POSSIBILITIES

BY

A. M. LOW

Late Hon. Asst. Professor of Physics
at the Royal Artillery College
Author of "The Two-Stroke Engine," etc.

With four diagrams

NEW YORK
E. P. DUTTON & COMPANY
681 Fifth Avenue

Copyright 1924
By
E. P. DUTTON & COMPANY

All Rights Reserved

Printed in the United States of America

TO
JOHN LOW

PREFACE

The effects of history upon the advance of science are often noted, but the result of the march of progress is more often entirely neglected.

It would seem desirable that the future should be studied with reasonable accuracy if we are to protect ourselves from the ill-effects and obtain the benefit from the good fortunes of invention.

A.M.L.

WIRELESS POSSIBILITIES

INVENTION

Considering the very evident fact that we owe every detail of our lives, every little comfort which separates us from the cave-man, to the science of invention, it seems strange that so long should have elapsed before this remarkable faculty received proper recognition.

Invention, in many ways, is the science and art of continuity of thought. The inventor is often referred to as a strange person; very true, very necessarily true when we realise that his doings must be strange or new, to be of value. To train oneself to forget the smell of the beefsteak when hungry

and to continue the natural sequence of ideas which may be passing through the mind, is to train the brain to improve. If we can but sweep a crossing a very little cleaner than that next to our own, perhaps we have surely accomplished one of the greatest duties of all.

If not one day is spent without something learnt, surely we have achieved the greatest object of work and enabled ourselves to realise that there are no such things as basic facts.

Invention is not labour, for the latter is doing something we do not wish to do in some one else's time, and invention like all good things is a work of love. Possibly that is why it is never paid!

We are too apt, I think, all of us, to rejoice in our greatness as her devotees

rejoiced in the greatness of Diana of the Ephesians: we should realise every time we undress that we are little removed from the animal, and that before many centuries have passed we shall be held in almost universal contempt.

If that does not stir us to do our best, we are indeed a nation of shopkeepers. But even the proprietor of the meanest store relies on his powers of prophecy for his profits.

The science of wireless is but a few years old. We know about it little more than our schoolboy sons, and in many cases not so much; let us therefore be open-minded if we are still ignorant.

Commercial invention trusts too far to mass thinking: an original mistake is very closely related to an accomplishment.

THE IMPORTANCE OF SOUND IN WIRELESS

A few lines of history are desirable here. I do not mean the history controlled by the fact that William the Conqueror made many important appointments in A.D. 1066 or that Stephen was particularly busy in A.D. 1100. I mean the history of wireless, for, although Radio Science is new, it has a history; all time is relative, and we ourselves are functions of that phenomenon.

Only a few years ago the efforts of wireless experimenters were entirely directed to the converting of the extremely delicate wireless oscillation,

still but little understood, into a mechanical movement, in order that the motion of electrons in a problematical aether (which may be nothing but a thought projection and which may exist in many different forms) might be altered into something readable by a man with a check waistcoat and a stock and share list in his hand.

That particular use, and the information that one army is about to kill another could be transmitted to headquarters, naturally occurred to everyone as the first valuable applications of Radio.

The many devices, the electro-magnetic receivers, tape machines, coherers, syphon recorders and the thousand and one electrical machines produced at

the time for these purposes, have practically all gone.

Even when to-day we want to send messages quickly, we record them upon a Dictaphone and rely almost entirely upon the sense of hearing.

Sound, the regular oscillation, and noise, the irregular oscillation, of the air, are really the beginning and end of wireless as it is known to the public to-day.

I would go further when thinking of the public. They do not want to sit with a telephone upon their heads, even if their ears may be improved thereby. They require to walk into a drawing-room, and having stood for a moment upon the mat, they must be able to cross the room, touch a button in a fretwork cabinet, and by the move-

ment of a lever be able to place themselves in touch with any part of the world. Paris, Hong-Kong, London, all must be one to them if we are to get their money for our art.

In other words, we are compelled to use what we now designate the "loud speaker." We have got to project a sound into the room before we can sell our instruments, and therein lies one great difficulty.

In the first place we dare not exaggerate the movements of a delicate telephone very much or we shall spoil it —therefore we construct something which looks very much like a magnified telephone with a trumpet upon it. The mechanism is naturally rather heavy as regards the moving parts.

In order to vibrate these heavy parts with the aid of our aetherial oscillations we have to amplify the available current, and during this process we naturally spoil the detail, or, in other words, we magnify it so much that electrical distortions occur through the whole range of various transformers and other items sold by every shop in the world—at double their value.

Most people are not content with a gentle sound: they find it necessary to express their joy at having reached their home by dancing; consequently they want plenty of sound, and they do not mind if it turns into noise.

They will tell you boldly that their wireless set with a couple of dozen foreign-made valves can be heard right

across a large street, a street by the way in which we still permit as much nerve-shattering noise to occur as is thought necessary. This means that we must have quite a big movement on a diaphragm of large size, and a large diaphragm is made to move by the electrical oscillation, itself not very accurate; naturally, if it is heavy, like a poker or anything else, it has a will of its own, and therefore it continues to move when the wireless oscillation has told it to stop. It does not even commence to move when it is told to do so, as it would were it a thin delicate telephone diaphragm from which accurate music can be obtained.

This means further distortion, and so bad is it that a great many people say

plainly that they will only listen to wireless concerts through a telephone and that they will only use crystals to obtain rectification because of the inaccuracies otherwise unavoidable to-day.

But this is not business, because do not forget we must have our cabinet with a fern upon it and beautiful music, if we are to be successful. Business always leads science, as we know.

Now think why it is that we need this big diaphragm moving so hard to get a big noise; let us neglect electrical details and consider what produces the noise; or sound, if we are lucky.

Sound is unfortunately purely a mechanical phenomenon as we chiefly understand it, and is produced by oscillations, alternate compression and

rarefaction of the atmosphere. Unlike the aether, which sometimes oscillates only too readily, air is a heavy material and has great mass.

You will soon find this out if you put your head out of a railway carriage window, because the air is so heavy that we have got to really kick it and hit it hard before we can obtain a reasonable degree of noise.

When a speaker is standing at one end of a room, irrespective of what he says, the actual temperature-rise of the air can be measured, a fact which was used during the war for the inspection of sound.

Sound is a very complicated thing. It can be reflected in much the same way as light, and I suppose most school-boys

know that if a concave mirror is at one end of a room and a similar mirror at the other with a watch hanging at its focus, the watch cannot be heard by an observer walking across the room, yet as soon as he places his ear at the focus of the other mirror he will hear the tick clearly, showing that sound is easily reflected. Everybody who has heard an echo should know this.

Sound travels also very slowly, and there is plenty of time for wind and different mechanical scraping effects to spoil the purity and partially absorb its delicacies.

Remember that if I am addressing a man by wireless who is one hundred miles away, someone who is listening on a telephone will hear my voice

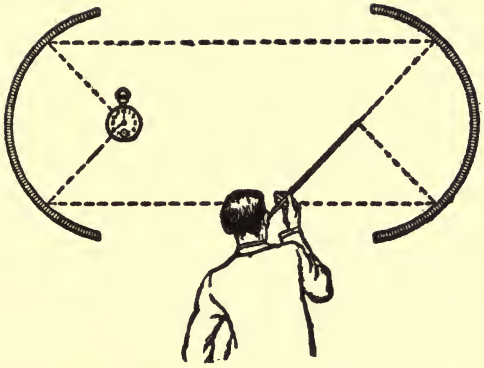

Fig. 1. Sound can be focussed by a concave reflector and by this means the tick of a watch can be heard at a distance. The watch and the end of the wooden rod are placed at the focus of the reflector.

before I am heard at the end of the big hall where I am speaking, because the velocity of sound is only 1100 feet per second, and wireless, like light, travels much faster. Sound can also be actually refracted. Just as the old-fashioned jeweller used a globe of water to concentrate the light upon his work, so will a collodion balloon filled with carbon dioxide, the ordinary gas product of average combustion, act as a lens for sound, which can be actually focussed by these means.

This exemplifies the complication of our subject, and indicates that the heavy diaphragm and other details of the loud speaker must produce serious distortion.

Let us be honest at once. We can only

hear such distant places as America by the grace of heaven. Even Sunlight can tune sweet song into vague cracklings. Until true tuning can be obtained we are largely at the mercy of the reproducing instrument, which too often exaggerates every fault and gives the impression that wireless and music are in no way related. No loud speaker of to-day really produces voice and song which sound exactly like voice and song. It all too much resembles a bad gramophone, but without the advantage of the user having the choice of the music.

If user and manufacturer would concentrate upon obtaining purity, if they would try the effects of damping upon loud speakers, which are easily

obtained; if they would realise that the horn of the loud speaker should be without resonance, that it should be also damped and pocketed, that its goose-necked shape is not adopted without an object, and if they would aim at the delivery of true music instead of noise—then, we should make a great advance. The average loud speaker can often be greatly improved by padding the horn with some kind of tape, and as an example of the great difficulties of proper transmission let it be made quite clear that with most cases of wireless communication the sending is nearly perfect. Reception is greatly at fault: it is the reception that mangles the sound and makes it too often

almost unbearable to anybody of reasonably sensitive hearing.

At some large transmission stations it was at one time quite common to use three separate microphones for the modulation. One received notes of high pitch, one of low, and a third attempted to obtain the "S" sound with the result that, when this "S" microphone was adjusted for a man who did not say his "S" very loudly and someone appeared who did, it sounded exactly as if the speaker had dropped his false teeth.

All this is now avoided. The ordinary diaphragm is no longer in use, but a very small coil of aluminium wire is suspended between the poles of an electro magnet, allowed to rest against

an ordinary pad of cotton wool, and that is all !

The infinitesimal movements of this aluminium coil will reproduce speech up to about 40,000 periods per second in oscillatory speed, yet speech is well recognisable if all frequencies over 4,000 per second are gridded out.

How difficult it is going to be to make a large, heavy, and rapidly moving diaphragm reproduce accurately when we have had to take all these precautions to obtain accuracy of transmission! It is not impossible; it will come one day.

Now let us see what is the result of our sound troubles.

We are told that before long it will be quite easy to hear birds singing in

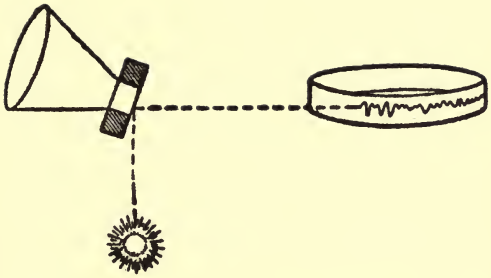

Fig. 2. If light falls on a very thin diaphragm carrying a mirror, the sound waves being directed into it by a trumpet can be photographed upon a revolving sensitised film.

trees and the waves beating against the seashore. Quite right, quite easy to do it now, but if a bird singing in a tree sounds like a man moving his condenser or walking about with a pair of squeaky boots, is it progress?

Perhaps it is. The whole point of wireless is that it brings a man into your room, but it must sound like the man himself if it is to be really effective; it is this pitiful quality of reproduced sound that has wrecked the talking cinema.

It is very easy to photograph sounds and to reproduce them simultaneously with the projection of a picture, but to reproduce all the sounds of a cowboy scene accurately is, at present, almost impossible. If a hero says "Good-bye"

to a heroine with a kiss like a creeking board, in the middle of a twenty-reel drama, instead of improving upon the effect of your imagination, which tells you that it is real, and which acts the scene for you better than it can be shown in life or sound, it would be like putting up a blackboard across the screen with the words written upon it, "this is not real—it is only a fake." That is what is wrecking the talking cinema. As a scientific proposition it is easy, but the results are not good enough at present, and, if we can improve, let us first consider the loud speaker.

The talking cinema will come as a matter of course. It is so easy to record sounds upon the film by

photography with reproduction by the selenium cell or the neon tube; it is easy to photograph the wave; it is easy actually to impress the sound wave upon the film with the picture, or to use a gramophone; but reproduction is not like a human voice. Neither as yet is any reproduction ever like the voice itself. Let that painful fact be remembered.

Unfortunately, from the business point of view, the long distance reproduction effect is usually satisfactory even when re-broadcasted upon telephones, and for business purposes it is immaterial whether the voice that records the profit or loss is harsh or pleasant.

So the greatest effects we shall soon

see from wireless and sound are these: we shall be able to speak to people all over the world by relaying and a combination of land-line and radio; we shall easily be able to connect our office with a wireless station on the coast, radio across the Continent, and then connect by land-line to another office on the other side of the Atlantic.

All this is so easy that no one can doubt that we shall soon listen in to native jamborees; no one can doubt that we shall hear the strange cries of partisans at a baseball match taking place a few miles from New York; no one can question these things, and when reproduction becomes so accurate that the very nature of the people is revealed to us through their speech, surely we

might be a little more neighbourly even with those whom we now pretend to love? Relations are notoriously quarrelsome.

If you are in a concert hall and the number of people is varied, it will alter the effect of the sound. You have only to look at a sound-wave photograph produced from a violin to realise from its dainty intricacies that the least variation of any of its harmonics or the very exact shape of its wave beats will reveal all the difference between a beginner and the finest musician in the world. But these things are seldom noticed in wireless.

It is quite easy to photograph a sound, by means of a diaphragm beside which a soap bubble is thick, and

to compare wireless sound with the original; even then we have the great difficulties of resonance, and a diaphragm cannot reproduce properly. How, therefore, dare we neglect the dreadful sounds we hear in the name of radio music?

If a piece of silvering, one thirty-secondth of an inch, be scraped from the back of a mirror and fastened to the outer part of a celluloid diaphragm (made by water-floating a drop of amyl acetate in which celluloid has been dissolved), it only requires a horn and a beam of light to render visible the waves of sound. A diaphragm movement of a millionth of a millionth of an inch is sometimes audible.

It is the science of wireless that is

beautiful; it is the possibilities that are wonderful; but to talk of pure sound and to judge of it by the human ear which varies after every meal, is like measuring the amount of current passing through an electric-light bulb by feeling its heat with the hand.

It is not generally known that, during the War, experiments were made with a sound-reflector for listening to different types of aeroplane and submarine, by means of a microphone placed at the centre of a concave mirror. The difficulty was that of distortion, which is the whole source of trouble with sound producers to-day. Distance is no difficulty and when we can obtain purity and realism as well as distance, the latter is no difficulty at all; then

only will be the time when we shall have that spontaneous mental realism of vision that will help radio to alter the world.

In a few years time we shall be able to chat to our friends in an aeroplane and in the streets with the help of a pocket wireless set, and be able to do practically everything by the aid of radio that we now do with our voice.

The only thing that will seem intensely strange will be that these comforts never existed before!

WIRELESS INACCURACIES

I have often wondered whether people realise that broadcasting, at present, is only possible or, shall I say is only popular, because of its extreme impracticability for most forms of secret communication.

Supposing two people had been able to converse privately and with absolute secrecy from other "listeners in," then we should not mind trusting all our messages to Radio. At present, what can be coded can be decoded, and we are not entranced by the idea of entrusting our pennies to the winds of

Heaven and the vagaries of a thunderstorm.

If wireless had really been selective in the first instance, broadcasting would not have been its initial phase.

Wireless at present is excessively inefficient; a few yards from a large broadcasting station the power is measured in millionths of a horse-power, is disseminated in all directions, and is almost without definite selectivity.

When the day comes when we can tune with absolute accuracy; when we can combine waves with accuracy and obtain a directional beam with the shortest waves for re-broadcasting purposes, then we shall obtain real happiness from the results.

Parliament must have its special

wave length, the divorce courts of the future will be broadcasted to prevent people from catching cold by waiting outside. It will be quite easy for the Judge, at a doubtful passage, to press a switch and to say, "I think we will cut that out."

One can imagine broadcasting of the future linking up every city from China to London; one can see special wave lengths for men, and equally special wave lengths for women. And we shall forget the time when ships at sea with ancient sets interfere with the murdering of music by the local amateur.

It has been said that, at present, those in authority find it necessary to choose special voices for the wireless

broadcast-delivering. What an idea! The public want to hear everybody. They want to have local events broadcast, irrespective of the operator. They do not want a perfect voice, they want a perfect personality, and it is rather the wireless that must be altered to take any reception than the human voice whose very characteristics delight us.

We are too accustomed to relying upon our senses. We are apt to think that the ear is most delicate. It is nothing of the kind; it cannot even hear notes that delight the heart of a dog, and if one pictures life with the brain of a man, the ear of an antelope, and microscopic eyes, together with the nose of a dog, some little idea of the inefficiency of those few senses which

we slightly understand can be obtained.

To live in any town would be impossible: the smells of Bond Street instead of pleasing the dog would tell us of rotting animal matter and alarm us to distraction. We could never sit down upon a beautiful piece of grass without listening to the worms and imagining ourselves with them. We could not bear to drink water for the peculiar bodies we would see in it. The wind in the trees, the people walking down our street or into our rabbit-warrens of flats, would sound like a battle from afar.

It is only a question of relative senses, easily tested by anyone who has the patience to fit an effective microphone to the amplifier purchased in

mahogany case at the local "store."

Wireless inaccuracies abound; anyone who hears its music will agree, but what of their effect upon our bodies!

The air, popularly speaking, must now be full of radio oscillations, and if you tell me that they are negligible in effect I may believe you, but if I hear there is no effect at all, I know that it cannot be true.

It is more than likely that, in the far future, the proper study of oscillatory theories, the proper investigation of the spectrum only very partially explored by a few, will lead us to a better understanding of the nature of life, and will help us to appreciate the theories of electrical sonics. Theories of pre-

venting local thunderstorms, of growing babies and wheat effectively, by electrical or other similar oscillatory means, of helping ourselves to see by wireless and of affecting our health at the end of many generations for the better, may all be developed in the time to come.

If some health effect is produced, why should we not try to render it beneficial? A small effect can be very cumulative in nature. One has only to inspect a human nail to agree with that statement.

RADIO TELEVISION

It has been said of sound that a bell never ceases to echo and that the human voice never ceases when once words are spoken; truly, it is an alarming thought when the nature of most of our sayings is realised.

Not long ago it was claimed that by means of a delicate microphone the sayings of Henry VIII had been investigated — though nature of the subject was, with not less delicacy, omitted.

Much the same basic ideas apply to light except that we are dealing with

a very much more interesting phenomenon, one indeed which is not apparently too material and a sense which gives us nearly all our non-physical sensations.

We actually transmit very few senses: we merely convert their nature by utilising different portions of the spectrum. Light has undoubtedly its tone values, as in the case of sound, and it has not yet been definitely established with what portion of the body vision is actually obtained. It is likely that light is projected along the electro lines of force by the movement of electrons but whether the ether consists of electrons themselves, whether it exists in many forms, or is merely a result of the mass effect of thought,

we do not yet know. Light very possibly proceeds from the eye as well as from the luminous body concerned.

The science of Radio has taught us something of light, but only to a modest extent, for light yet remains one of the most inefficient factors of a civilisation which almost entirely depends upon it for existence.

There is a strange factor which we may call the "Law of Supply and Demand." This strongly implies the faculty of invention, a facility of "wishfulness to improve"; something far better than the necessity for invention. Let us remember that our clothes are not necessities; they are merely comfortable, and it is comfort that distinguishes us to-day just as it

is convenience that will in the future give us a life which will be better by far than that experienced by the kings and princes of to-day.

Civilisation has depended almost entirely upon the speeding up of communication. We can travel fast; we can convey our thoughts at great speed, but, unfortunately, although all these means of intercommunication are devised with the one idea of preventing physical work and of obviating the movements of our gross bodies, our senses are very closely combined. It is consequently not possible to ring up somebody on the wireless telephone, a fact itself easy of accomplishment, and to impress our personality upon the listener. This is simply because we

require a combination of senses for hearing, seeing, smelling, and other reactions, in order to convey our whole personality.

Vision at a distance is, therefore, very necessary as our inclination for travel decreases and its comfort increases.

It is also important from the point of view of "speeding up," which we have no reason to suppose will cease. All operations have steadily increased in speed for many generations.

There was a time when we made appointments to meet our friends at the full of the moon, but now we say at "10 o'clock, and I can only give you two minutes." In the future we shall probably say, "Meet me at 10.2.1-5 secs., and do not keep me waiting." To

do this we must have radio sight.

Many years ago, when experiments were made on the subject, the usual cry appeared from what I always mentally typify as the "Flat Earth Brigade"; they said, "Impossible." What would our forebears have said of talking to a man in an aeroplane? "Impossible!" It is a foolish word. Now all over the world experiments are being conducted, many of them with success and some with the guarantee of reasonable success in twenty years or less.

Now wireless, if I may apply the word here, is very like light in many ways; it is capable of refraction and shadow effects; it travels at the same speed, and if the wave-lengths of wireless could be sufficiently shortened to become visible

we should probably find ourselves with a new, and possibly effective, method of transmitting wireless light and even power.

Radio is a phenomenon of the spectrum like ordinary photographic light, X-rays, and so on. It is effects which determine the difference to our eyes of things invisible, solid, and transparent.

It may well be that, when we succeed in inter-planetary communication, we shall discover that the inhabitants see by the X-ray, by wireless, or by heat.

It is not difficult to obtain a proportionate interchange of radio and light oscillations. Even sunlight affects wireless telegraphy, and experiments which have been conducted upon the

carrying and directional power of certain other rays and oscillations have not been entirely without results. We may, one day, obtain far greater sensitivity of direction, greater carrying power, from small initial output with a degree of selectivity almost infinite, in comparison with modern working.

To use a light beam along which we can talk, to use a light beam initially and to turn it into light when required, is by no means difficult; it suggests the direct method of wireless vision, but from the mechanical aspect the problem is still less complicated. The difficulties of Radio Television to-day are constructional; in the far future it may be a question of pure physics.

There is, at least, one simple method

of sending photographs by wireless with a reasonable degree of accuracy. Distance, re-broadcasting, relaying are, none of them, of any great technical importance. Interference is certainly a difficulty, for in the case of a picture the eye cannot distinguish between faults so easily as the ear can automatically separate unpleasant noises from music.

If an ordinary photograph is transferred to a copper plate, either flat or round, and a contact finger is allowed to pass over it, clearly the resistance between the plate and the finger will vary with the thickness of the photographic film. If this resistance is used to modulate the transmission in place of an ordinary microphone for speech,

the current at the receiving end can be picked up, amplified, and used to mark darkly, lightly, or not at all, upon a prepared piece of paper which is affected by the passage of an electric current.

By these means good photographs can be reproduced, and doubtless in the future we shall be able to sign our cheques by the rapid transmission of motion; we shall be able to trace criminals, send out their finger-prints, and carry on very many classes of business which, at present, require our bodily attention.

What a help to the man who objects to a large city. Why could he not conduct his business from his house in comfort instead of having his spats

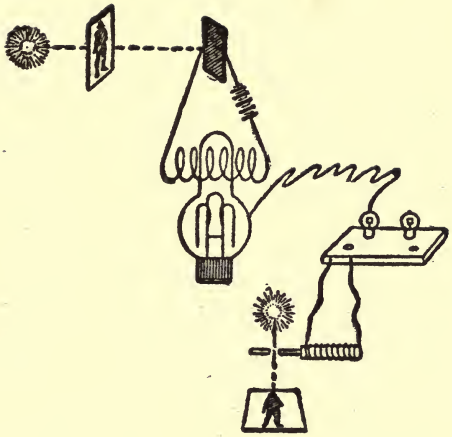

Fig. 3. If light passes through the negative to be transmitted on to a selenium cell which modulates in place of a microphone, the wave can be picked up, amplified, and made to open or close a shutter. This permits another light to record, spot by spot, the reproduction of the original photograph.

washed every week in order to maintain his financial reputation ?

There is a still more rapid method of transmitting a photograph : it is to allow the light from an ordinary lamp to pass through a spot upon the negative and then to a selenium cell. Selenium is so constituted that its resistance to the passage of electricity varies with the amount of light to which it is exposed. This property has been used to light up and to extinguish ordinary street lamps, for demonstration purposes.

If a selenium cell is used in place of the ordinary broadcasting microphone, the transmission can be modulated in accordance with the passage of the light through a black spot on the negative, such as part of a top hat, or a white

spot, such as a white face or part of it.

The received current is picked up and amplified in the ordinary manner, but instead of operating a diaphragm to produce speech, it is taken to a kind of electrically operated venetian blind, which allows light to pass through it or not to pass through it, in accordance with the transmitting current.

It requires little imagination to see that, if a beam of light is allowed to pass through each point of the original negative in turn, the final picture can be built up from "spots" somewhat in the manner of a half-tone block.

It takes a long time, is rather patched, and is liable to interference; but the whole process is perfectly simple. Con-

sider the great importance of this experiment to Radio Television.

The human eye sees only one point at a time but in the fact that instantaneous vision of a complete picture is not necessary lie our hopes of television to-day.

The eye is a very defective piece of mechanism considered from an optical standpoint. The pointed rays which appear to come from stars show one example of faulty optical construction, however wonderful may be the whole structure. Another property, and a feature of great importance from the aspect of television, is that of retentivity.

We all know that when a lighted cigarette is whirled round in the hand the result appears to be a ring of fire.

Our brain assures us that the eye is telling lies and that it is really a moving point. This is because the image is impressed and actually lasts upon the eye or its retina.

This phenomenon is used in every cinematograph; without it the ordinary film would not be practicable. Each picture of an arm about to light a cigarette shows the arm constantly closer and closer, and before one picture has had time to die out the other is thrown upon the screen. The result is an illusion of motion.

To return to the transmission of a photograph, let us imagine that it is sent in a series of spots beginning in the top left-hand corner at 12 o'clock: the bottom spot will probably be com-

pleted, at modern sending speeds, by about 12.15, in the case of a picture two inches square.

Clearly all we have to do is to reduce this time to 4/5 of a second altogether, and we shall be again sending the first spot before it has had time to die away from the apparent vision of the observer. In other words, we will see by wireless.

The obvious method of assisting in this speeding up of sending the thousands of spots, would be to graduate them by some means of rotary conversion or to decrease the number of spots. The latter is one method by which practical television can be accomplished to-day.

It would be quite easy to fix up an apparatus by means of which we could

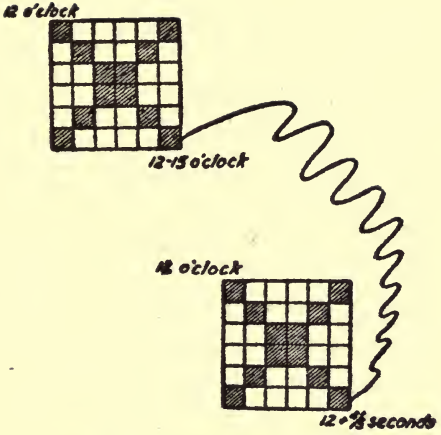

Fig. 4. If a photograph is divided into spots and the last be sent only $\frac{2}{3}$ sec. after the first, television can be obtained; but if the spots must be large to do this, only such items as the difference between a cross and a circle can be observed.

show whether an office in New York was lit up or not, the observer being situated in London. This is a form of energy or combination of phenomena which amounts to wireless sight, but it does not help us to see shapes or forms or to say if the light is from a candle, the sun, or an arc lamp.

By increasing the number of cells from one to, let us say, twenty, we could possibly indicate the difference between the moving shadow of a cross or a circle, but to radiate detail is a very difficult problem, which doubtless will be partially solved within the next few years. The electro-magnetic theory of light and the phenomena exhibited by the neon tube, present many opportunities.

What an excellent invention this will be! It means that a telescopic camera could be attached to an aeroplane and the views seen by thousands in a cinematograph theatre who may have the pleasure of witnessing the finish of a horse-race and knowing without loss of time how much money they have lost.

It would mean that the crew of a ship, a submarine in difficulties, or the passengers in an aeroplane, might be visible to people many miles away. It could not yet occur without their wish, for the transmitting apparatus must first be put into operation.

The senses of seeing and hearing are possibly amongst the most important of all, and, if we can convey both of

them to a distance, it means that we can call friends, nations, music, and personalities to our fireside, by the touching of a button.

Such possibilities need no enlargement. Wireless may prove a far more rapid link than the ordinary increase of travelling speed and may help nations to intermingle to the common good.

The question of seeing in colours has hardly yet been considered, but that also will come to us, however great the difficulties may appear to-day.

Certainly Leagues of Peace will have more arguments, and Generals will have more weapons.

The laziest millionaire to-day, in a physical sense, will be hard-worked in

comparison with the fortunate individual of the scientific future. We will travel in the best possible manner and in such comfort that the mind will be free to receive impressions. Our main objective will be to train it for that purpose.

After all, what more can we do now ?

WIRELESS AND WAR

The subjects of War and Wireless cover a multitude of closely allied ills.

It is only natural that wireless should first have been applied to Love and War. I remember well one of the most remarkable applications of wireless mentioned in the press in the early days was that of a cable sent to an unfortunate man in mid-ocean, informing him that an all too successful arrival of twins had taken place.

War is, of course, a natural process a little less educated, and more unkind, in consequence, than birth control.

WIRELESS AND WAR

Most inventions are first applied to the science and art of warfare. Perhaps we should not regard this as all to the bad, for War has a remarkable capacity for acceleration.

Development of the wireless valve was greatly assisted by the War: the aeroplane, the art of plastic surgery, and many other human benefits have arrived more rapidly from the same cause.

Let us see, therefore, what wireless can do now, and what it may accomplish for the future of organised destruction.

Mentally, the fittest should survive, in both the realms of invention and physiology. It is only a few years since wireless was of no intrinsic value

for ordinary land warfare, by virtue of the fact that interference was extremely easy, and that any coded message could be so easily decoded.

At present wireless messages are chiefly of service where secrecy is not of such importance as speed; but an enormous number of experiments are being conducted upon beam wireless, directional wireless, and in the combination of the Radio oscillation with some other oscillations such as those of visible or invisible light. By these means secrecy will be obtained when we discover how to use small powers for long distance, but at present Radio is chiefly of value as a time-saver.

The pilot in an aeroplane can talk to his base: he will soon be able to

write and transmit vision from a plane which could be controlled by wireless. The time will come when low-flying wireless planes will explore, and render visible at many miles distant, places where no human pilot could remain for any length of time in safety.

It is not long ago that we rejoiced because a damaged ship was able to call for help by wireless, but we have only to look back to a recent war to remember an occasion when one ship was totally unable to call assistance because its wireless was jammed. In other words, enemy interference was possible.

This should show us how far we have yet to go in an utterly new and very little understood science.

We began with sparks, we progressed to coherers, and now we have valves; but let it not be thought for a moment that the valve represents finality to any thinking being.

Broadcasting at present has really become so universal only on account of the exceedingly public nature of wireless, for, when we are able to obtain accuracy of tuning and direction, we shall not only use the latter to guide ships at sea, but we shall have correspondence which can be conducted with a reasonable degree of secrecy. We shall have special wave-lengths for the Government, special wave-lengths for Parliamentary debates, and the Divorce Courts. We shall not conduct our conversations in such a manner that

any schoolboy with a piece of wire, a needle, and some sugar, can promptly listen in.

The very idea suggests a new "Peeping Tom."

As far as communication is concerned, we shall have whole armies in instantaneous touch with each other: it may indeed make real secrecy more difficult. It should always be recollected that when we refer to wireless speech, wireless control, and Radio Vision, we do not necessarily mean the same form of electrical wave by which we now broadcast a comic opera.

It is with oscillation that we are really concerned, and we may discover many forms of electronic vibration at present occupying portions of the

so-called spectrum which are as yet very little understood.

It may be impossible for the Commander-in-Chief of the future to conceal a document from the eyes of wireless; and who knows but that the electrical operation of thought may be reduced to a science so that our very ideas are not secret without protection?

How many of us to-day could risk all our thoughts being known? It would probably improve moral standards if they were published: science tends to effect an average improvement.

We have never yet really seen the extraordinary value of wireless in war. If we had solved the problem of selection, the transference of speech by phonograph records dropped from

aeroplanes would never have arisen.

Undoubtedly, we shall see wireless controlled tanks, submarines, and torpedoes on both land, air, and water. All will be accurately controlled, and they will possibly be able to find their way home and to operate from a distance while out of sight.

Even to-day it is possible for an aeroplane to operate a torpedo, to steer it properly, to slow it down; and for a pilot of an aeroplane many miles away to work his will upon it with a reasonable degree of accuracy and with the help of a gyro control.

The day will undoubtedly come when the problem of defending an island is not that of the mainland itself but of all its dependencies.

No large town could live for long if it were bombed from a distance by wireless, if gassed and poisoned from a distance, were it not for the balance of protection and defence which is usually maintained by nature.

We shall in the future, see forms of electric death and heat-rays which may materialise not as a direct projection of heat but as some form of oscillation which produces heat only when striking a metallic object.

We have been so often told that power can be transmitted by Radio that we are apt to look upon this statement with contempt. This is quite wrong: power will one day be transmitted by wireless; power can at present be inductively sent over quite

a large air gap, though the energy available quite close to any wireless station is practically negligible to-day.

When motor-cars and ships are controlled or stopped by wireless, it is not the wireless which does the work; the etherial oscillation merely sends signals to the ordinary operative mechanism.

Much excitement has been caused by the alleged injury of aeroplanes and motor-cars by wireless, but how is it that they can afterwards proceed? Do we forget that the petrol engine has to be restarted, and that, if allowed to fire when a car was in gear, it might be damaged and would probably not operate the moving parts?

If wireless power could be directed

in such a form that it could be conveyed along a wave of "atomic" oscillation, many more valuable ends might be served than the enforced landing of aeroplanes.

Our clocks could be corrected by wireless, experiments could be conducted upon the nature of light and ether in various forms. We might decide the mode of propagation of light and thought, and investigate the apparent motion of the electron along the electro lines of force.

What an opportunity for study to the man of medicine! What a chance to find out how the oscillations of life are connected with those we partially understand.

What a chance for the burglar to

discover the presence of hidden spoons as a mass of metal by means of wireless; what a chance for the surveyor and the seeker after oil to use this all-prevailing sense of oscillation and even to discover the meaning of radiation.

Oscillation—that is all we mean by Radio; and oscillation is at the base of life itself. It will not be long before travellers by air, land, and water, will be no longer alone.

That they will be able to converse with their homes may seem no advantage, but that they can remain in touch with the rest of mankind is most obviously desirable.

If this were understood to-day, I should not need to make noises with my lips or require the simulacra of

these noises to be produced upon paper to convey my thoughts. If thought is a process of energy-conversion—and who will deny it ?—what form of screening prevents its use, and why should its reception be confined eventually to life upon this particular and very troublesome planet ?

It is remarkable how little is known of wireless: the very simplicity of its painfully standardised features is a trap for the unwary. It is a universal science, but we do not yet know the correct diaphragm size for a loud speaker, nor how damping should be employed. The finest apparatus is available to all, and yet we do not understand the fullest range of wave-lengths. The study of radio-active materials

and short wave radiation may in one day produce the cold-emitter valve, abolish the outside aerial, and bring to our closer understanding some of the many senses now so atrophied in mankind, that we can only speculate as to their existence. I doubt much if the schoolboy of the future will greatly esteem the radio expert of this century.